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THE LIFE-HISTORIES OF THE NEW YORK SLUG CATERpillARS.—XIII-XIV.

PLATE I, FIGS. 1-12.

BY HARRISON G. DYAR, A.M., PH.D.

Packardia geminata Packard.

1864—*Cyrtosia geminata* PACKARD, Proc. Ent. Soc. Phil. III, 343.

1864—*Cyrtosia albipunctata* PACKARD, Proc. Ent. Soc. Phil. III, 344.

1865—*Cyrtosia ocellata* GROTE, Proc. Ent. Soc. Phil. IV, 322.

1866—*Packardia geminata* GROTE & ROBINSON, Ann. Lyc. N. H. N. Y. VIII,

373.

1880—*Packardia goodellii* GROTE, Can. Ent. XII, 242.

1894—*Packardia geminata, albipunctata* NEUMOEGER & DYAR, Journ. N. Y. Ent. Soc. II, 109.

LARVA.

1891—DYAR, Trans. Am. Ent. Soc. XVIII, 157.

1891—DYAR, Can. Ent. XXIII, 277.

1893—PACKARD, Proc. Am. Phil. Soc. XXXI, 107. (as "*Larva of Heterogenea* (*Tortricidia* ?)")

1894—DYAR, Ann. N. Y. Acad. Sci. VIII, 222.

SPECIAL STRUCTURAL CHARACTERS.

Dorsal space moderately broad, flat, narrowing to both extremities, arched; lateral space broad, oblique; narrowing to the ends; subventral space two-thirds as wide as the lateral one, distinct, only slightly retreating, suddenly narrowed in front, tapering behind. Ridges tubercular and setiferous till the last molt, then smooth; subdorsal ridge obsolete, indicated by the rounded angular change in direction between back and sides; lateral ridge slight, dividing the lateral and subventral spaces, subtubercular even in the last stage. Setæ at last rudimentary; in stage I with the structure and arrangement of *Apoda y-inversa* except that the subdorsal spines have the short branch very

rudimentary and the third spine of joint 2 is lacking. Body elongated, sides subparallel, rounded toward the anterior end, joint 13 produced into a slender pointed tail. Skin covered with large, irregular, conic not contiguous, clear granules. Depressed spaces (1) to (8) present, small, ill defined, but devoid of the coarse granules. Color very whitish green, opaque; a white line along the subdorsal ridge with upper dark green, clear border. The centers of the depressed spaces are also whitish, but obscured in the general white shading; (1) and (4) have green centers, but not contrasting. A fainter white line along lateral ridge and subventral edge. The larva is whiter than the backs of the leaves on which it rests, a condition necessary to offset the dark shade which its thickness produces when looked at from beneath. The larva stands about on the same level as *A. y-inversa* in degree of specialization, exceeding it in the presence of the tail-like modification and slightly more reduced setæ of stage I, but falling behind in coloration.

AFFINITIES, HABITS, ETC.

This species belongs to the group of which *Apoda biguttata* is typical, the palaearctic smooth Eucleids. It departs a little from this type as noted above, but not in important characters. Its nearest ally is the other species of the genus, *P. elegans*. The moths emerge unusually early in the season, at the same time as *Tortricidia testacea*, at or before the middle of June. The females rest quietly and do not fly at all till after pairing, even though several nights intervene.* Normally emergence from the pupa takes place during the day, the moths pair the subsequent night and the eggs are deposited in the next night. Flight of the males begins rather late at night, not till after 9:30 P. M. The eggs are deposited singly on the under side of the leaves. The larvæ frequent dry woods and bushes on the edges of fields. They do not inhabit damp or dark locations. Very often the larvæ are found on low small plants only a few inches from the ground, and they are never high feeders. Larvæ occurred not uncommonly at Bellport, Long Island, in a dry pine and oak woods on small wild cherry bushes which had about six leaves apiece and did not exceed a foot in height.

* Most ♀ Eucleids fly on the second night after emergence, and if not mated the previous night, refuse the ♂ entirely. *Phobetron* and *Calybia* are an exception, for they will mate after an infertile flight, but in this case the eggs are without vitality, most only proceeding to the first embryonic stages, and those that do hatch never live to mature.

This species has a northern range. I obtained it at Jefferson Highlands, N. H., in the White Mountains, where only a few species of Eucleidæ are found. Its southern limit is not known, though it occurs throughout New York. It is one of our rarer species, yet locally fairly common.

There are six or seven stages. The former number is here described. When seven stages occur, the extra one is interpolated after stage *V*. It resembles stage *V* closely, the white depressed spaces being a little more distinct, setæ large. The larva under observation fell behind in length from the measurements given more and more in each stage, but attained the same final size, owing to the extra stage. The young larva possesses distinct urticating power, in spite of the absence of stinging spines. The sharp setæ, though not converted into true spines, probably function similarly.

CRITICISM OF PREVIOUS DESCRIPTIONS.

I have given the characters of the mature larva several times. I suppose Dr. Packard's brief description of an unidentified form to have been taken from this species, although the description is scarcely determinate. It could hardly be anything else, however.

In the present descriptions I have gone a little beyond my brief in including in the synonymy the dark forms *albipunctata*, *goodellii* and *ocellata*. Nothing but the pale form *geminata* was bred from these larvæ, so that there is a possibility of another species.

DESCRIPTION OF THE SEVERAL STAGES IN DETAIL.

Egg.—Rather narrowly elliptical, flat as usual, translucent white on glass, shining like a wet spot on the back of the leaf; $1.3 \times .7 \times .1$ mm. Reticulations rather distinct all over the egg, but much rounded, like circular shallow pits, varying a little in size. They hatch in 14 days.

Stage I.—Rounded, thick, tail rounded; spaces all of moderate width, the subventral one small. Color translucent whitish. Spines transparent, short, clubbed-tipped, the subdorsal ones on joints 5, 7 and 9, leaning out slightly and the lateral one of joint 5 leaning up. Joint 2 not much retracted, a large cervical shield with several fine setæ. The subdorsal spines on joints 4–12 have just a trace of the side branch, seen in certain lights as a small irregularity. Skin smooth; slight segmental hollows are present dorsally at the upper sides of the bases of the tubercles. Arrangement of the setæ (Plate I, fig. 2), as in *Apoda y-inversa* except that there is only one middle seta on joint 4. The outer third

of the seta is everted from the middle portion on hatching, sometimes remaining incompletely so. No spines present on first emerging from the egg. Length, .9-1.7 mm.

Stage II.—(Plate I, fig. 2.)—Rather elongated, elliptical, tail rounded quadrate, joint 3 truncate in front. Setæ normal, two on the subdorsal ridge, one on the lateral, distinct, long, sharp pointed. The middle row on the thorax is represented by two setæ on joint 3, and by one only or a large and a small one on joint 4. Ridges distinct, the dorsum and sides concave. Head retracted; joint 2 partly so. Skin rather densely frosted with clear conic granules, not contiguous, nowhere produced into secondary spines. Depressed spaces hardly indicated (1) as slight hollows, not differentiated by the granules and very small. Color pale whitish green, evenly tinted. Length, 1.6-2.5 mm.

Stage III.—Narrowly elliptical, tail small, square. Dorsal and lateral spaces broad, subventral smaller. Ridges marked, high, segmentarily tubercular, the setæ stiff, black, distinct. Color plate translucent whitish green, a faint white line under the subdorsal ridge, not reaching either extremity. Skin with remote, low, rounded granules (Plate I, fig. 4), no spines anywhere. Depressed spaces small, shallow, not sharp edged, smooth in the bottom. Length, 2.3-3.5 mm.

Stage IV.—Elliptical, tail produced a little and tapering, notched. Whitish green, a distinct white band below the skin of subdorsal ridge on joints 4-13. Lateral ridge prominent, even with the subventral edge or a little beyond it. Dorsal impressed whitish dots (1) distinct on the central segments, interrupting the faint green line of the dorsal vessel. Skin smooth except for the remote, irregular, clear granules, the surface slightly sunken to represent the depressed spaces. Length, 3.5-5.2 mm.

Stage V.—Somewhat more like mature larva; tail truncate. Skin more densely clear granular, the granules nearly contiguous. Subdorsal ridge with a distinct yellowish white line on joints 3-13; a row of dorsal dots (1), only five of them distinct (joints 5-9). Ridges gently undulating from the outline of rudimentary tubercles. Setæ short, distinct. Depressed spaces indicated, but like the rest of the skin, granular. Color, translucent green, dark, not yellowish. Head green, eyes black. Length, 5.2-7 mm.

Stage VI.—(Plate I, fig. 6.) Shape as described. Skin granules transparent, contiguous, covering the whole surface. Depressed spaces very small, the dorsal (1) smooth, whitish with green centers; addorsal ones (2) absent on the surface, but represented by white dots below the

skin. Lateral large areas (4) and (6), indicated by pigment under the granules, the smaller ones not represented. Tubercles obsolete, setæ minute. The body is elongate, rather narrow, highest through joints 7-8. Color, whitish green, becoming whiter during the stage as the pigment is slowly deposited. A dorsal green line interrupted by the dorsal impressed spots, subdorsal lines straight, yellowish white, connected on joint 3 and on the tail, edged above with dark green. A row of white dashes on the lateral ridge, the large depressed spaces (4) becoming whitish with dark centers like (1). Length, 7-11.5 mm.

Cocoon and pupa as usual.

Food-plants.—Wild cherry, white birch, black birch, oak, bayberry, sour gum, hickory and *Clethra alnifolia* have been observed.

Packardia elegans Packard.

1864—*Cyrtosia elegans* PACKARD, Proc. Ent. Soc. Phil. III, 342.

1864—*Cyrtosia fusca* PACKARD, Proc. Ent. Soc. Phil. III, 343.

1881—*Packardia nigripunctata* GOODELL, Can. Ent. XIII, 30.

1891—*Packardia elegans* DYAR, Trans. Am. Ent. Soc. XVIII, 157.

1894—*Packardia elegans* NEUMOEGER & DYAR, Journ. N. Y. Ent. Soc. II, 76.

LARVA.

1864—PACKARD, Proc. Ent. Soc. Phil. III, 343 (cocoon; no larva).

1881—GOODELL, Can. Ent. XIII, 31 (brief desc.).

1890—PACKARD, 5, Rept. U. S. Ent. Comm. 149 (quotes Goodell).

1891—DYAR, Can. Ent. XXIII, 277.

1893—PACKARD, Proc. Am. Phil. Soc. XXXI, 100.

1894—DYAR, Ann. N. Y. Acad. Sci. VIII, 222.

SPECIAL STRUCTURAL CHARACTERS.

Elongate elliptical, rounded before, joint 13 produced into a pointed tail. Dorsal space rather narrow, diminishing a little at the ends, slightly arched, highest at joints 6-7; lateral space broad, concave; subventral space broad, narrowly retracted in the middle. Ridges moderate, the lateral the most distinct, subtubercular, setiferous; smooth in the last stage. Skin rather coarsely clear granular, always without secondary spines. Depressed spaces feebly developed, (1) and (4) show faintly as pale rings, seen by transparency as if at the bottom of pits with convergent sides. Pigment unusually scanty; a band of green color extends along the upper half of lateral area below the subdorsal ridge, elsewhere the body is transparent, faintly colored greenish by the blood. Dorsal vessel plainly seen and the contents of alimentary canal, showing through the dorsal space. At the end of the last stage the

pigment fills in somewhat better. Tail conic, setæ of joint 13 widely separated on it. First stage as in *P. geminata*.

AFFINITIES, HABITS, ETC.

Closely allied to *Packardia geminata*, differing only slightly. The granulation is more dense, appearing earlier in ontogeny, but the pigmentation is much degenerated. The moths do not emerge as early in the season as *P. geminata*, yet fairly early, June 25th to July 2d, in my examples. The females are less quiescent than the allied species and fly violently if not mated the first night after emergence. After this night they will not mate at all, even though males be present, but continue to lay infertile eggs, or else refuse to lay and die in a few days. The eggs are deposited singly on the under sides of the leaves where the larvæ live.* The larvæ frequent dark woods. The deep shade seems to be the essential factor as they will occur in any woods whether wet or dry if dark enough. I have found them on the thin pale leaves in the dry woods on Goat Island at Niagara Falls and also in an almost swampy grove in Van Cortlandt Park, New York City. I have found them on Long Island, not commonly, as dark woods are rare on the Island. The larvæ are low feeders, but not so low as *P. geminata*. As in the case of its ally, the larvæ can be found in fair numbers by looking in the right places. Except by breeding the moth is seldom taken.

CRITICISM OF PREVIOUS DESCRIPTIONS.

Mr. Goodell mentions the larva without detailed description. Subsequently it has been described adequately by Dr. Packard and myself. Dr. Packard describes a series of dorsal dark green spots which he says "does not form a tubercle or flattened wart." This is, indeed, very true, because the spot is the center of the dorsal depressed space. I suppose the only reason for making this statement to be the same false idea of the homology of these structures to which I have referred under *Tortricidia fasciola*.

* Professor Poulton remarks (Trans. Ent. Soc. London, 1888, p. 591), "it is well known that these larvæ (Eucleidæ) rest on the upper surface of the leaves of their food plants." I cannot imagine on what this statement is based. Of the nineteen species of North American larvæ now well known to me, only one (*Phobetron pithecium*) ever rests on the upper side of the leaf, and this in the last stage only when its peculiar shape and color make it resemble a piece of dead leaf that had fallen from above. I cannot well believe that the two European species have different habits from our smooth Palearctic Eucleids.

DESCRIPTION OF THE SEVERAL STAGES IN DETAIL.

Egg.—Elliptical, flat, $1.0 \times .6 \times .1$ mm.; whitish transparent, colorless. Reticulations distinct, irregularly quadrangular, narrow, raised. In the bright light with the green leaf behind they appear as narrow black lines, bordered by a bright area on both sides, the flat cell-areas dusky grayish. They hatch in 10 or 11 days.

Stage I.—Just like *P. geminata*, the spines arranged the same (Plate I, fig. 1); all short with irregularly knobbed tips. Branches of the sub-dorsal spines just distinguishable as little protuberances. Elliptical, rounded, dorsum and sides grooved, subventral space small. Ridges smooth, setæ colorless. Skin shining, smooth, colorless, transparent; food green; head concolorous. Length, .8–1.4 mm.

Stage II.—Obscure, not shining, pale whitish, just tinted with green, translucent. Elongate elliptical, narrow, the tail narrowly quadrate. Ridges slight, non-tubercular, two setæ on subdorsal ridge, one on lateral ridge, normal, except only one on the middle row of joint 4; black tipped and with stout expanded bases. Skin granules small, sparse, low conic, clear, alike everywhere, not produced on the ridges. The largest depressed spaces, (1) and (4), are indicated as slight hollows. Length, 1.3–2.1 mm.

Stage III.—Elongate elliptical, narrowing posteriorly, tail rounded, not produced. All frosted whitish, scarcely tinted with green. Setæ distinct, sharp, black tipped, arising from slight tubercles on the subdorsal ridge, distinct conic segmentary ones on the lateral ridge. All of skin surface and tubercles covered densely with small low conic clear granules, uniformly even over the obsolete depressed spaces, where they are scarcely thinner. The granules are very numerous, almost contiguous, but rounded, not appressed. (Plate I, fig. 5.) The shape is now unusually narrow, dorsal space not narrowing much to the ends. Very colorless, translucent, the blood only slightly green and no pigment present. Length, 1.8–3.0 mm.

Stage IV.—Narrow, elongate, truncate before; tail produced, but tubercular like the ridges. Frosted whitish from the granules and, therefore, slightly opaque; almost entirely without pigment, the blood visible pulsating, slightly green tinted. An obscure whitish dot under the subdorsal ridge at each intersegmental space, representing a subdorsal line. Setæ short, black and distinct. Granules small, even, dense, but not quite contiguous, running uniformly over the whole surface; depressed spaces scarcely indicated anywhere. Length, 2.8–4.0 mm.

Stage V.—Elongate, anterior end rounded, posterior pointed but without a well formed tail. Dorsal space moderate, even, but little arched, lateral broad, subventral moderate. Ridges low tubercular, with distinct dark setæ. Skin clear granular, whitish; all very transparent, green pigment only in the upper half of lateral space, none in dorsal space which appears darker from the food showing by transparency. A waved subdorsal line, bent inward on the interspaces, free at the ends. Depressed spaces not visible, except faint white rings to represent the lateral ones (4). Length, 3.8–5.8 mm.

Stage VI.—Narrowly elliptical with a pointed tail; setæ short, black, distinct. Pigment in the upper half of lateral space, the rest of the body clear green from the blood, translucent and whitish in the edges. A wavy yellow subdorsal line, free at the ends. Dorsal depressed spaces (1) very faintly indicated by whitish dots, visible centrally only; lateral (4) as large intersegmental white rings, but probably at least the glands of all the spaces (1)–(8) are present, as drops of moisture were observed in the appropriate position of them all in the larva under observation. Skin granules rather coarse, dense, but not contiguous, the depressed spaces not differentiated. Length, 5.0–8.5 mm.

Stage VII.—(Plate I, fig. 9, 10). Shape as described. Patches of pigment in the dorsal space surround the rings of depressed spaces (1). Light yellowish green, lateral edge clearer, dorsal space darker. A waved, narrow, yellow, subdorsal line, free at the ends; tail reddish brown above. The absence of pigment in the dorsal space makes it look hollow, though it is really flat. Six of the depressed spaces (1) are visible as white rings, around which more or less light emerald green pigment forms in rings, transverse bands or even filling all of the dorsal space (Plate I, fig. 10.). The subdorsal line is composed of a series of intersegmental, inwardly lunate, joined yellow marks. Lateral space to lower edge of depressed spaces (4) pigmented light green, (4) large pale rings with dark centers. A trace of pale dots along lateral ridge intersegmentally. Tail long, pointed; setæ very small, pale. Skin granules rather large, somewhat irregular, not quite contiguous, at the largest depressed spaces, (1) and (4), less distinctly granular over the slight hollows. A broken white subventral line. Length, 7.1–13 mm.

Cocoon and pupa as usual.

Food-plants.—Linden, witch-hazel, hop-hornbeam, beech, maple, black birch, wild cherry, sour-gum, black oak, chestnut, hickory and *Leucothoë racemosa*, have been observed.

EXPLANATION OF PLATE I.

- Fig. 1. Stage I of *Packardia*, dorsal view, enlarged.
 " 2. Stage II, side view enlarged.
 " 3. The subdorsal setæ of one tubercle, stage II, more enlarged.
 " 4. Granules of *Packardia geminata*, stage III, enlarged.
 " 5. Granules of *Packardia elegans*, stage III, enlarged.
 " 6. Mature larva *P. geminata*, three-quarters view.
 " 7. Moth of *P. geminata*.
 " 8. The same, dark form. var. *albipunctata*.
 " 9. Mature larva of *P. elegans*, three-quarters view, partially pigmented.
 " 10. The same, dorsal view, fully pigmented form.
 " 11. Moth of *P. elegans*.
 " 12. The same, pale form, var. *fusca*.

AN ATTEMPT TO CLASSIFY THE HOLARCTIC LEPIDOPTERA FROM THE SPECIALIZATION OF THE WINGS.

PART II.—THE HAWK AND EMPEROR MOTHS.

BY A. RADCLIFFE GROTE, A.M.

- C.** Radius 5-branched; vein IV₂ central or cubital; hindwings with intercostal crossvein.....SPHINGIDES.
c1. No costal vein (vein I) on primaries; vein III₂ absorbed by Radius; crossvein degenerate; vein IV₂ decidedly cubital.....ENDROMIDIDÆ.
c1. A costal vein (vein I) on primaries; vein III₂ from Radius before extremity of cell; crossvein entire; vein IV₂ not decidedly cubital
SPHINGIDÆ.
D. Radius 3-4 branched; vein IV₂ central or radial; hindwings with no intercostal crossvein.....SATURNIADES.
d1. Vein IV₂ continuous with vein IV₁.....SATURNIADÆ.
d2. Cell openATTACINÆ.
d2. Cell closed.
d3. Hindwings without vein VIII.....SATURNIANÆ.
d3. Hindwings with vein VIII.....HEMILEUCINÆ.
d1. Vein IV₂ from crossvein.....AGLIADÆ.
d4. Hindwings without vein VIII.
d5. Crossvein, between IV₂ and IV₁, directed obliquely outwardly
AGLIANÆ.
d5. Crossvein transverse.....AUTOMERINÆ.
d4. Hindwings with vein VIIICITHIERONIADÆ.*

* This table (*C, D*), and that of the Day-Butterflies (*A, B*), is compiled in accordance with the sequence in the Lepidoptera which I recommend, and not altering the Linnean arrangement upon opinionative grounds.